

at one stage, by opening up or shielding the surface, may settle its behaviour at a later date.

Corrosion of Condensers.—The case of steam condensers has been the subject of prolonged study by a committee of the Institute of Metals and affords an illustration of the difficulty of dealing with corrosion in practice. The giving out of condenser tubes is nearly always due to the metal being attacked by substances in solution in the circulation water, and these are usually the same as cause corrosion in steam boilers. In the latter, if the trouble is serious, it can be dealt with by chemical treatment of the feed-water, but in the case of circulation water the enormous volume renders such treatment impracticable. In the case of steamers the difficulties are increased by the fact that sea- or river-water, often of doubtful quality, must be employed. These circumstances determine that instead of mending the water, amelioration must be sought in the direction of choosing a metal that will offer maximum resistance to attack, and of arranging details of construction and of operation so as to ensure the fewest opportunities of intensified action on the surface.

Choice of Metal for Condenser Tubes.—The prevailing practice is to manufacture the tubes of brass of the composition copper 70 per cent, zinc 30 per cent, but the purity of this mixture may vary according as electro-deposited or less refined metals have been employed. Where corrosion is troublesome or the conditions are likely to be severe, the substitution of Admiralty alloy of composition copper 70 per cent, zinc 29 per cent, and tin 1 per cent is suggested. In either case the iron should if possible not be allowed to exceed 0.1 per cent. A brass containing 2 per cent of lead has been found serviceable, and in the case of acid waters the employment of an alloy of 80 per cent copper and 20 per cent nickel or of an arsenical copper may be necessary. The crystalline structure of the drawn metal is susceptible of improvement as regards resistance to corrosion, and this can be obtained to some extent by subjecting the tubes to an oxidizing annealing for 3 hr. at $(660 \pm 45^\circ \text{ F.})$. The annealed tubes should not be subsequently

pickled.

Effect of Lodgments.—The combined action of water, air, chlorides, and carbonic acid upon the brasses gives rise to mixed basic salts of copper and zinc of variable composition and colour. Sometimes these appear to act as a protective covering; others, such as cuprous chloride, behave differently and actively promote oxidation. If at any point the latter become attached to the surface, a centre of corrosion is established and pitting will probably ensue. Any lodgment of foreign matter, even though itself chemically inert, obviously favours the attachment of such activating substances and may thereby promote local corrosion. Increasing the speed of the water current suggests itself as a means of preventing or lessening such deposits, but on the other hand the risk is thereby incurred of dislodging protective scale which may have formed on the surface and be a very efficient safeguard, so that the remedy must be used with judgment.

Foaming Waters.—Conditions that give rise to foam intensify cor-